

PURCHASE DESCRIPTION

CALIBRATOR, MULTI-FUNCTION

02-3243 Rev B

- 1.0 GENERAL** This procurement requires a multi-function calibrator to calibrate multimeters, frequency counters, oscilloscope, pressure, and equivalent equipment.
- 2.0 CLASSIFICATION** The equipment shall meet the requirements of MIL-PRF-28800F class 4 for Navy shipboard, submarine and shore applications. The following exceptions and additional requirements are invoked.
- 2.1 Warm-up The required warm-up time shall not exceed 30 minutes.
- 3.0 OPERATIONAL REQUIREMENTS** The unit shall meet all the accuracy requirements specified herein when the operating temperature is maintained to within  $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$ . Outside of this range, a temperature coefficient of not more than  $[0.1 \times \text{stated accuracy}/^{\circ}\text{C}]$  is allowed. As a minimum, the equipment shall be capable of providing AC and DC voltage and current, resistance, and capacitance. The equipment shall simulate electronic temperature indicators such as thermocouples and resistance temperature devices (RTD's). The equipment shall source frequency for calibration of counters and be capable of providing the necessary functions to calibrate oscilloscopes up to 600 MHz. Capabilities for pressure calibration and relative humidity measurement shall also be provided.
- 3.1 DC voltage characteristics The equipment shall meet the requirements of Table I for sourcing DC voltage. Positive and negative polarities shall be available.

Table I – DC Voltage

Output Range	Resolution	1 Yr. Accuracy $\pm$ [% of output + $\mu\text{V}$ ]	Load Current [Minimum]
320 mV	0.1 $\mu\text{V}$	0.003 + 1.5 $\mu\text{V}$	5 mA
3.2 V	1 $\mu\text{V}$	0.002 + 2.0 $\mu\text{V}$	10 mA
32 V	10 $\mu\text{V}$	0.002 + 15 $\mu\text{V}$	10 mA
320 V	100 $\mu\text{V}$	0.002 + 150 $\mu\text{V}$	5 mA
1000 V	1 mV	0.002 + 1.5 mV	5 mA

- 3.2 AC voltage characteristics The equipment shall meet the requirements of Table II for sourcing AC voltage.

Table II – AC Voltage

Output Range (Vrms)	Frequency	Resolution	1 Yr. Accuracy (Sinewave) ±[% of output + μV]	Load Current (Minimum)
32 mV	10 Hz to 10 kHz	1 μV	0.08 + 6 μV	0.6 mA (50 Ω)
	10 kHz to 50 kHz		0.1 + 6 μV	
	50 kHz to 100 kHz		0.8 + 50 μV	
320 mV	10 Hz to 10 kHz	1 μV	0.05 + 8 μV	5 mA (50 Ω)
	10 kHz to 50 kHz		0.04 + 8 μV	
	50 kHz to 100 kHz		0.2 + 70 μV	
3.2 V	10 Hz to 10 kHz	10 μV	0.03 + 50 μV	10 mA
	10 kHz to 50 kHz		0.03 + 50 μV	
	50 kHz to 100 kHz		0.07 + 125 μV	
32 V	10 Hz to 10 kHz	100 μV	0.03 + 650 μV	10 mA
	10 kHz to 50 kHz		0.04 + 600 μV	
	50 kHz to 100 kHz		0.09 + 1600 μV	
320 V	45 Hz to 1 kHz	1 mV	0.02 + 2000 μV	5 mA
	1 kHz to 10 kHz		0.02 + 6000 μV	
	10 kHz to 20 kHz		0.03 + 6000 μV	
1000 V	45 Hz to 1 kHz	10 mV	0.03 + 10000 μV	2 mA
	1 kHz to 5 kHz		0.03 + 10000 μV	
	5 kHz to 10 kHz		0.03 + 10000 μV	
<b>Note:</b> For non-sinusoidal waveforms the voltage 1 year accuracy shall be ±[5.0% of output +0.5% of range] for frequencies between 10 Hz and 1 kHz.				

- 3.3 DC Current characteristics The equipment shall meet the requirements of Table III for sourcing DC current. Positive and negative polarities shall be available.

Table III – DC Current

Output Range	Resolution	1 Yr. Accuracy $\pm$ [% of output + $\mu$ A]	Load Voltage (Maximum)
3.2 mA	10 nA	0.015 + 0.03 $\mu$ A	4V
32 mA	100 nA	0.01 + 0.2 $\mu$ A	
320 mA	1 $\mu$ A	0.01 + 2 $\mu$ A	
2.2 A	10 $\mu$ A	0.02 + 40 $\mu$ A	
11 A	100 $\mu$ A	0.05 + 330 $\mu$ A	2.2 V

- 3.4 AC Current characteristics The equipment shall meet the requirements of Table IV for sourcing AC current.

Table IV – AC Current

Output Range (Arms)	Frequency	Resolution	1 Yr. Accuracy (Sinewave) $\pm$ [% of output + $\mu$ A]	Load Voltage (Maximum)
320 $\mu$ A	10 Hz to 5 kHz	0.01 $\mu$ A	0.4 + 0.15 $\mu$ A	7 Vrms
	5 kHz to 10 kHz		0.8 + 0.2 $\mu$ A	
3.2 mA	10 Hz to 5 kHz	0.01 $\mu$ A	0.2 + 0.2 $\mu$ A	
	5 kHz to 10 kHz		0.5 + 0.3 $\mu$ A	
32 mA	10 Hz to 5 kHz	0.1 $\mu$ A	0.2 + 2 $\mu$ A	5 Vrms
	5 kHz to 10 kHz		0.2 + 3 $\mu$ A	
320 mA	10 Hz to 5 kHz	1 $\mu$ A	0.2 + 50 $\mu$ A	4 Vrms
	5 kHz to 10 kHz		0.2 + 100 $\mu$ A	
2.2 A	10 Hz to 5 kHz	10 $\mu$ A	0.6 + 1000 $\mu$ A	1.25 Vrms
10.9 A	45 Hz to 1 kHz	100 $\mu$ A	0.1 + 2000 $\mu$ A	

**Note:** For non-sinusoidal waveforms the current 1 year accuracy shall be  $\pm$ [5.0% of output + 0.5 % of range] for frequencies between 45 Hz to 1 kHz.

- 3.5 Resistance characteristics The equipment requirements for sourcing resistance shall be in accordance with Table V. The equipment shall employ both 2 and 4-wire techniques for lead resistance compensation.

Table V – Resistance

<b>Output Resistance</b>	<b>Resolution</b>	<b>1 Yr. Accuracy ±[% of output + mΩ]</b>	<b>Current Limit</b>
32.9 Ω	0.1 mΩ	0.004 + 15 mΩ	35 mA
329.9 Ω	0.1 mΩ	0.003 + 20 mΩ	35 mA
3.29 kΩ	1 mΩ	0.003 + 20 mΩ	5 mA
32.9 kΩ	10 mΩ	0.003 + 1 Ω	0.5 mA
329.9 kΩ	0.1 Ω	0.004 + 10 Ω	50 μA
3.29 MΩ	1 Ω	0.006 + 150 Ω	5 μA
32.9 MΩ	10 Ω	0.03 + 2500 Ω	0.5 μA
329.9 MΩ	1 kΩ	0.3 + 100 kΩ	50 nA

- 3.6 Capacitance characteristics The equipment requirements for sourcing capacitance shall be in accordance with Table VI.

Table VI – Capacitance

<b>Capacitance Range</b>	<b>Resolution</b>	<b>1 Yr. Accuracy ±[% of output + pF]</b>
3.3 nF	0.1 pF	0.5 + 10 pF
33 nF	0.1 pF	0.25 + 100 pF
330 nF	1 pF	0.25 + 320 pF
3.3 μF	10 pF	0.25 + 3 nF
33 μF	1 nF	0.4 + 30 nF
330 μF	10 nF	0.45 + 300 nF
1.1 mF	100 nF	0.45 + 1 μF

- 3.7 Temperature calibration The equipment shall meet the requirements for sourcing electronic temperature indicating devices in accordance with Table VII. The equipment shall employ both 2 and 4-wire lead compensation techniques for calibrating RTD's.

Table VII – Temperature

Thermocouple Type	Temp. Range (°C)	Resolution (°C)	1 Yr. Accuracy (°C)
B	600 to 800	0.1	0.55
	800 to 1000		0.41
	1000 to 1820		0.37
C	0 to 1000	0.1	0.31
	1000 to 1800		0.50
	1800 to 2316		0.84
E	-250 to -100	0.1	0.50
	-100 to 1000		0.21
J	-210 to -100	0.1	0.27
	-100 to 1200		0.23
K	-200 to -100	0.1	0.33
	-100 to 1372		0.40
L	-200 to 900	0.1	0.37
N	-200 to -100	0.1	0.40
	-100 to 1300		0.27
R	0 to 250	0.1	0.57
	250 to 1767		0.40
S	0 to 1000	0.1	0.49
	1000 to 1400		0.37
	1400 to 1767		0.46
T	-250 to 0	0.1	0.63
	0 to 400		0.17
RTD Type	Range (°C)	Resolution (°C)	1 Yr.Accuracy (°C)
PT385,100 Ω	-200 to 100	0.1	0.22
	100 to 630		0.30
	630 to 800		0.45
<b>Note:</b> The equipment shall be provided with selectable ITS-90 and IPTS-68 temperature scales and selectable 2- and 4-wire lead compensation for RTD measurements.			

3.8 Frequency characteristics The equipment shall provide the specified frequency outputs as

indicated in Table VIII for the purposes of calibrating frequency counters.

Table VIII – Frequency

Frequency Output	1 Yr. Frequency Accuracy	Minimum Voltage Output	1 Yr. Voltage Accuracy
50 kHz-10 MHz	2.5 ppm $\pm$ 5 $\mu$ Hz	3 Vpp	0.5 V

- 3.9 Current coil characteristics A current coil accessory shall be provided in accordance with Table IX for multiplying the equipment current output for calibrating AC and DC clamp-on current probes and meters.

Table IX – Current Coil

Frequency	Amp - Turns (No probe attached)	1 Yr. Accuracy $\pm$ [% of output + A]
DC	0 - 550 A	0.5% + 0.5 A
45 to 65 Hz	11 - 550 A	
65 to 440 Hz	11 - 200 A	0.8%

- 3.10 Oscilloscope calibration The equipment shall provide the functions as they are specified in paragraphs 3.10.1 through 3.10.6 for the purposes of calibrating oscilloscopes to at least 600 MHz.

3.10.1 Square Wave Characteristics: The equipment shall provide square wave source functions that satisfy the requirements specified in Table X.

3.10.2 DC Voltage Characteristics: The equipment shall provide a DC voltage source that satisfy the requirements of Table XI.

Table X – Square Function

Impedance	Out-put range (p-p)	1 Yr. Voltage accuracy [% output + $\mu$ V]	Frequency	Frequency accuracy	Rise time	Symmetry	Aberration (% output) within 20 ms
50 $\Omega$	4.5 mV-3 V	0.25% +100 $\mu$ V	1 kHz	2.5 ppm	$\leq$ 5 $\mu$ s	50 %	2% + 100 $\mu$ V
1 M $\Omega$	4.5 mV-130 V						

Table XI – DC Function

Impedance	Output Range	1 Yr. Voltage accuracy	Polarity
50 $\Omega$	4.5 mV-2.78 V	0.25%+40 $\mu$ V	Pos and Neg
1 M $\Omega$	4.5 mV-130 V		

3.10.3 Levelled Sine Wave Characteristics: The equipment shall provide leveled sine wave source functions that satisfy the requirements specified in Table XII.

Table XII – Levelled Sine Function

Im- peda- nce	Output Voltage Range (Vp-p)	Frequency	1 Yr. Frequency Accuracy	Voltage Accuracy [% output] (50 kHz ref.)	Flatness [% output] (50 kHz ref.)	Spectral Purity (50 kHz - 600 MHz)
50 $\Omega$	10.6 mV- 5.5 V	50 kHz REF.	2.5 ppm	2%+300 $\mu$ V	-	Harmonics: $\leq$ 33 dBc
		50 KHz - 100 MHz	2.5 ppm	-	1.5%+100 $\mu$ V	
		100 - 250 MHz	2.5 ppm	-	2%+100 $\mu$ V	Spurious: $\leq$ 38 dBc
	10.6 mV - 3.3 V	250 - 600 MHz	2.5 ppm	-	5%	

3.10.4 Edge Function Characteristics: The equipment shall provide edge source functions that satisfy the requirements specified in Table XIII.

Table XIII – Edge Function

Imped- ance	Output Range	1 Yr. Voltage Accuracy (% output)	Frequency	1 Yr. Frequency Accuracy	Rise Time	Aberration [% output] within 10 ns
50 $\Omega$	90 mV - 1 V	3%	1 kHz-10 MHz	$\leq$ 2.5 ppm	$\leq$ 1 ns	3%+2 mV

3.10.5 Pulse Edge Characteristics: The equipment shall be provided with a mainframe compatible external pulse edge source that satisfies the requirements specified in Table XIV.

Table XIV – Pulse Edge Function

Impedance (Output)	Output	Output Frequency (Fixed Within)	Frequency Accuracy	Rise Time	Aberration [% output]
50 $\Omega$	$\geq$ 250 mV	100 Hz - 100 kHz	2.5 ppm	125 - 175 ps	4%

- 3.10.6 **Time Mark Characteristics:** The equipment shall provide time mark source functions that satisfy the requirements specified in Table XV.

Table XV – Time Mark Function

Impedance	Function	Time/Div. (s)	Frequency Accuracy (±)	Minimum Output (Vpp)
50 Ω	Square	5 - 50 m	25 ppm+15 mHz	1 V
	Square	20 m - 100 n	2.5 ppm	
	Square	50 - 20 n		
	Square	10 n		
	Sine	5 n - 2 n		

- 3.11 Display Characteristics The unit shall be provided with a digital front panel display. The display shall provide a direct readout of the functions specified herein.
- 3.12 Calibration Software The equipment shall have the inherent capability and necessary software to remotely calibrate units-under-test via an ANSI/IEEE-488 interface to a dedicated instrument controller or a personal computer operating in Microsoft Windows 95 and Microsoft Windows NT 4.0 environments. The software must adhere to ISO 9001 paragraphs 4.11 a through j. Currently available software and procedures shall be shipped with each unit in CD format.
- 3.12.1 Procedure database: The software shall include the calibration procedures currently available to the commercial market. The software shall also include a calibration procedure for the multifunction calibrator.
- 3.12.2 Software: The software shall include drivers and programming language to allow the operator to modify existing procedures and to write and store on disk new calibration procedures. The software shall also include a database and an editor to store calibration results and generate calibration certificates.
- 3.12.3 Software and procedure upgrades: Throughout the life of the contract once every six months the calibrator shall have the calibration procedures and software upgraded to the latest version available on the commercial market. Throughout the life of the contract, if requested, the manufacturer shall develop calibration procedures to support equipment purchased under the Navy GPETE program. The new procedures shall be developed and delivered within six months upon receiving request from the Contracting Officer. Throughout the life of the contract the maximum number of new calibration procedures that the manufacturer has to develop is ten. Software and procedure upgrades shall be shipped in CD format to a focal point to be determined by the Contracting Officer.
- 3.13 Rackmount The equipment shall meet the convertible/rack-mountable requirements of MIL-PRF-28800F.
- 3.14 Optional pressure measurement and calibration Capability to measure pressure shall be provided as a line option for the equipment. Pressure module shall comply with specification in table XVI. A calibration kit to calibrate the pressure module specified in Table XVI shall be also provided.



Table XVI - Pressure Module

Range	Resolution	One Year Uncertainty	Max Overpressure	Fitting Material
-15 to 200 psi	0.01 psi	0.07%	3 x Nominal	Type 316 Stainless Steel
-100 to 1380 kPa	0.1 kPa			

- 3.14.1 Pressure units: psi, kPa, bar, mm. Hg, in. Hg, mm. H<sub>2</sub>O, and in. H<sub>2</sub>O
- 3.14.2 Pressure calibration kit: A calibration kit shall be provided to calibrate the pressure module specified in Table XVI. The calibration kit shall include all accessories needed to provide interfaces between under-calibrated pressure module and the calibrator/computer, pressure module calibration software, and a pressure pump for pressure sourcing. As a minimum the calibration software shall run under Microsoft Windows 98 and Microsoft Windows NT 4.0 environments.
- 3.14.2.1 Pressure pump: The pressure pump shall have the capability to produce pressure up to 200 psi. A vernier with at least ten turns shall be provided for fine adjustment of pressure. The length of the pump stroke shall be adjustable to vary the maximum output pressure.
- 3.15 Optional relative humidity measurement Capability to measure relative humidity shall be provided as a line option for the equipment. Humidity probe, software, and all accessories necessary for full use of the relative humidity measurement capability shall be provided.

#### 4.0 **GENERAL REQUIREMENTS**

##### 4.1 Temperature

- 4.1.1 Operating temperature: 5 °C to 40 °C.
- 4.1.1 Non-operating temperature: 0 °C to 50 °C.

- 4.2 Power source MIL-PRF-28800F nominal power source requirements are invoked. Maximum power consumption: 600 W.

- 4.3 Weight The equipment and accessories, excludes manuals and transit cases, shall have a maximum weight of 40 kg (88.2 lb).

- 4.4 Remote interface The equipment shall be provided with an ANSI/IEEE-488.1 interface in accordance with MIL-PRF-28800F. The interface shall be provided with full subset capability for the purposes of controlling the equipment remotely and performing closed-loop calibrations. The equipment shall be provided with all necessary cables.

- 4.5 Accessories The equipment shall be supplied with all leads, cables, adapters, terminations and any other accessories necessary for full use of the equipment

- 4.6 Training A multimedia CD showing the features and basic operation of the equipment shall be provided with each unit. The multimedia CD shall have hot links to allow end user promptly link to a desired section.

- 4.7 Battery restrictions Per MIL-PRF-28800F, lithium and mercury batteries are prohibited without prior authorization. A request for approval for the use of lithium or mercury batteries, including those encapsulated in integrated circuits, shall be submitted to the procuring activity at the time of submission of proposals. Approval shall apply only to the specific model proposed.

- 4.8 Calibration interval The calibration interval shall be 12 months minimum as in accordance with MIL-

PRF-28800F.

- 4.9 Technical manual Technical manuals shall be conformed with standard MIL-PRF-28800F. A Use and Installation manual (Operator's Manual) shall be provided separately. Maintenance and Servicing manual shall be provided with all three levels of maintenance; unit operational verification, module level, and component level. Technical manuals shall be provided in both printed and electronic formats. The printed format shall be otherwise normally provided. The electronic format shall consist of the installation programs for the latest version of Adobe Acrobat for all computer platforms for which Acrobat is available and the technical manual in an electronic form that is readable through use of the Adobe Acrobat application.
- 4.10 Optional transit case The equipment shall be supplied with a hard transit case as a line item option. The hard transit case shall have provisions for stowage of the equipment, the accessory case, and at least the Operator's manual. The transit case shall comply with the requirements of the MIL-PRF-28800F performance specification.
- 4.11 Year 2000 Compliance The manufacturer shall certify that the equipment is not susceptible to malfunction as a result of date/time functions associated with the calendar year 2000 or later.